



13a-A32-6

グラフェンに被覆された  
Cu{120}面の表面モフォロジー  
Surface morphology of Cu {120}  
covered by single layer graphene

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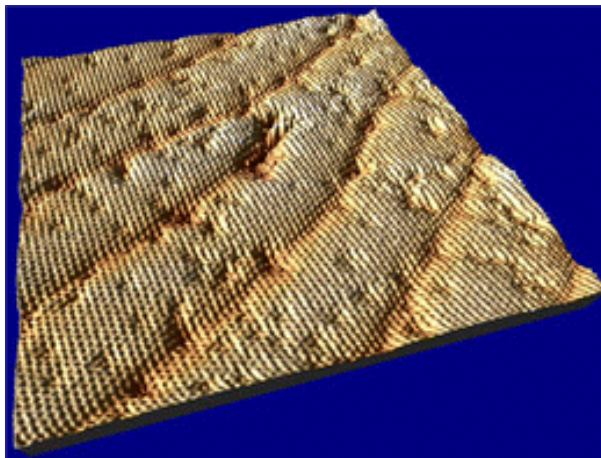
# Surface morphology of CVD graphene/Cu

Low index planes

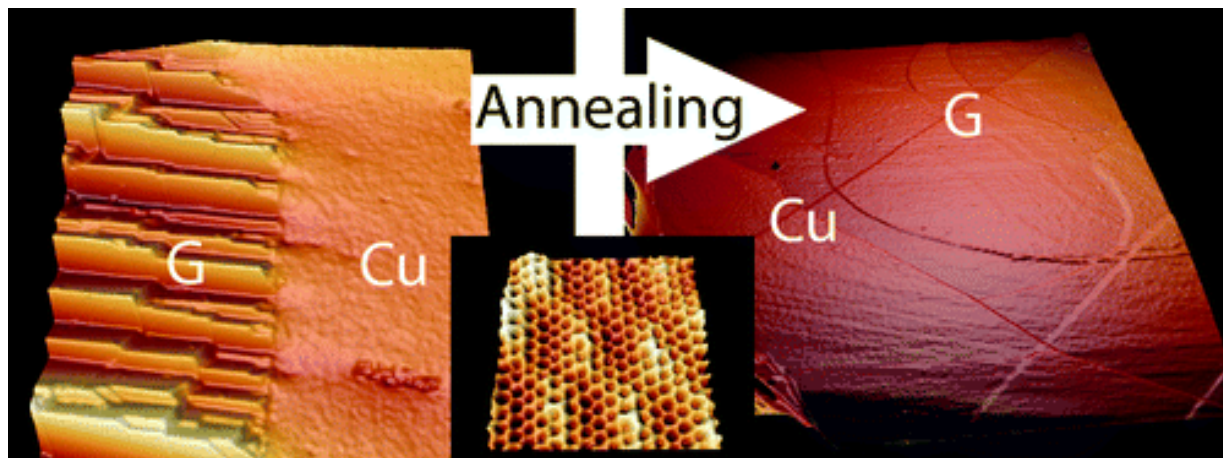
e.g.) Graphene / Cu(001)

- ✓ Annealing effect
- ✓ Reconstruction of Cu underlying graphene

Tian, J. *et. al*, *Nano Lett.* **12**,3893 (2012).



Cho, J. *et. al*, *ACS Nano.* **5**, 3607 (2011).



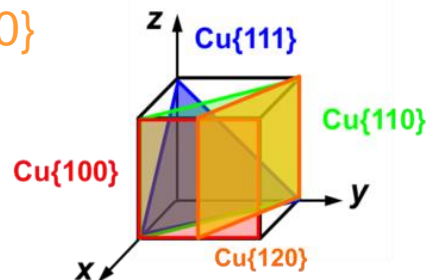
# CVD graphene/Cu {120}

## Annealed Cu-foil covered by graphene

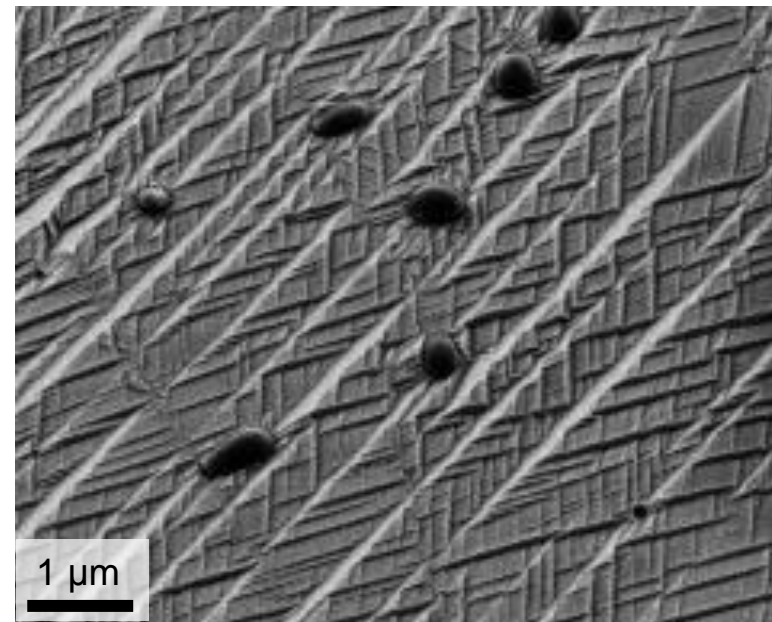
EBSD map  
(Electron backscatter diffraction)



Cu{120}



SEM images

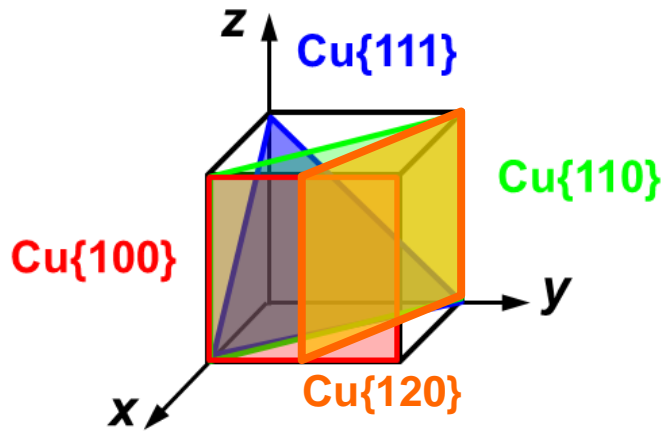


Step and terrace structures

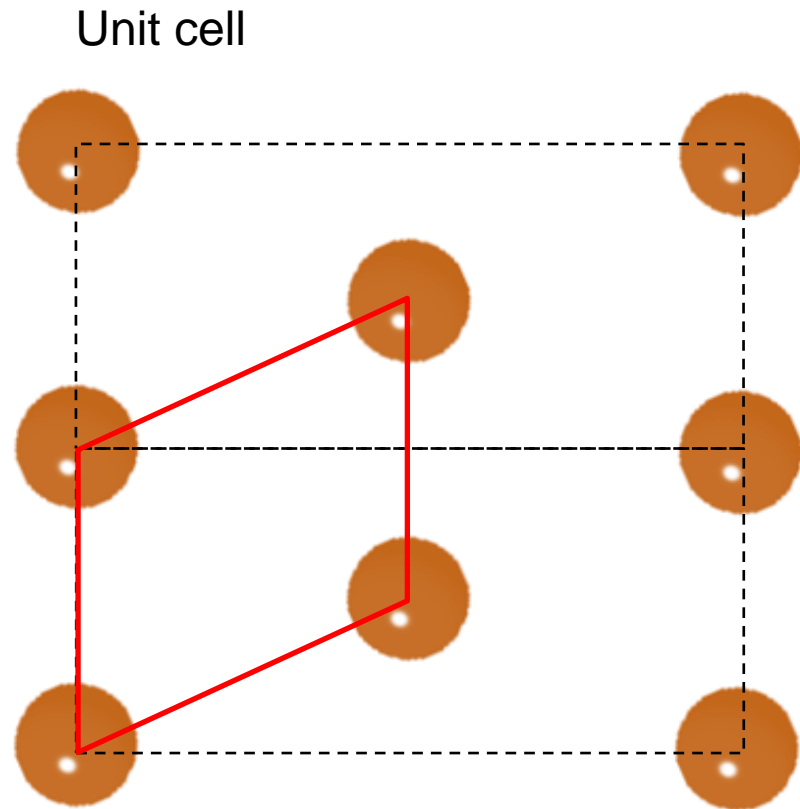
Aim:

Investigating surface morphology of Graphene/Cu {120}  
and effects of thermal annealing

# Definition of lattice parameters



Atomic arrangement of  $\text{Cu}\{120\}$  surface

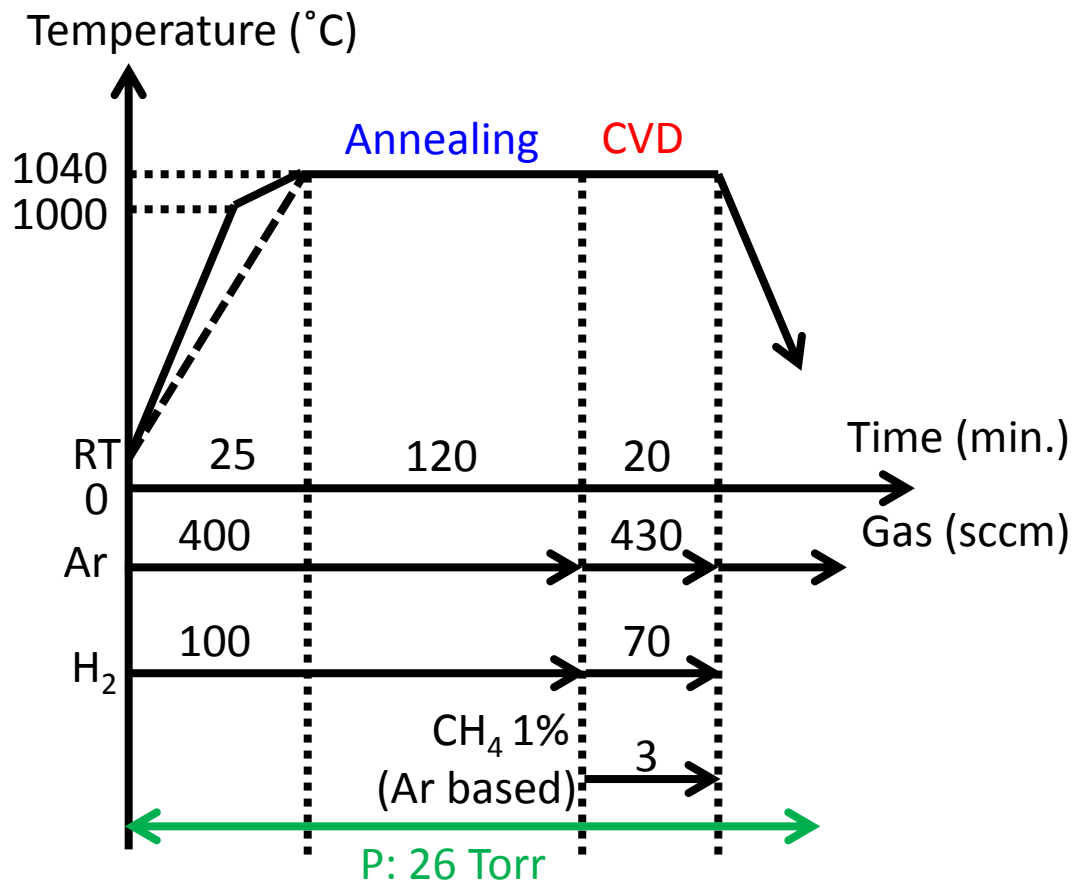


Primitive unit cell

# Experimental procedure



## 1. Sample preparation

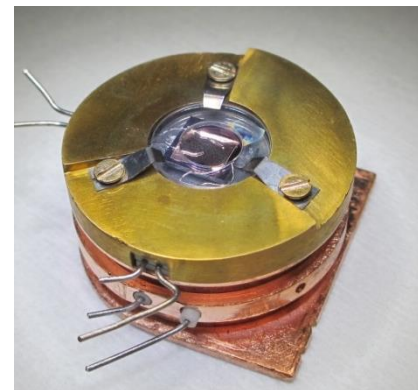


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## 2. Thermal annealing in UHV

### Annealing condition

- Pressure:  $10^{-9}$  Torr ~
- Time: 10 min
- 200 – 700°C, 100°C step

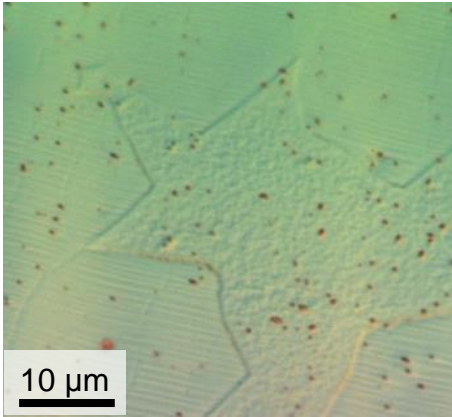


# Annealing effect for graphene

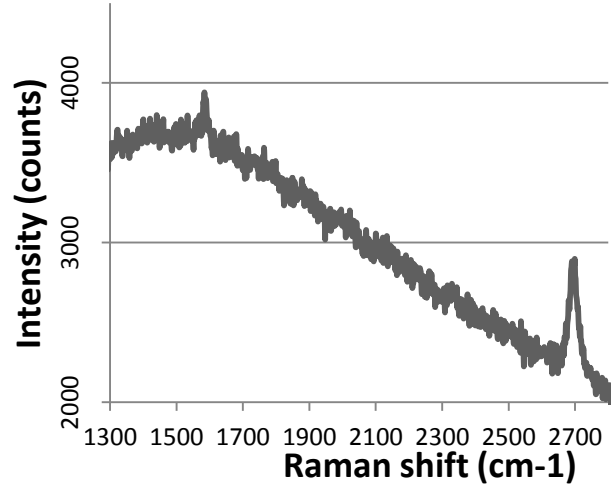


Optical micrograph

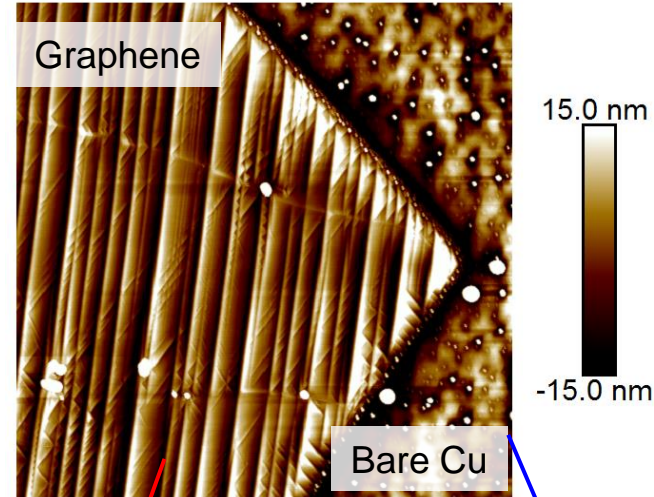
As-grown G/Cu(120)



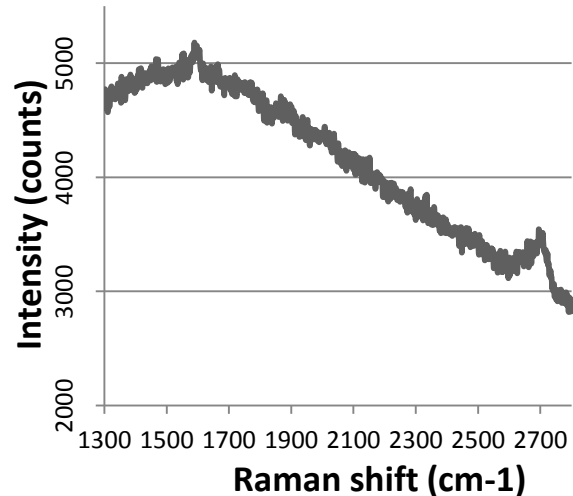
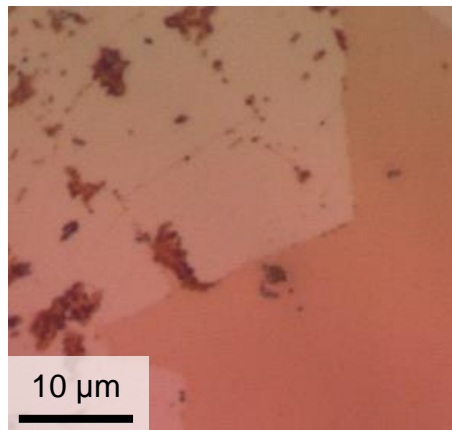
Raman spectrum



AFM image



After vacuum annealing  
above 500°C

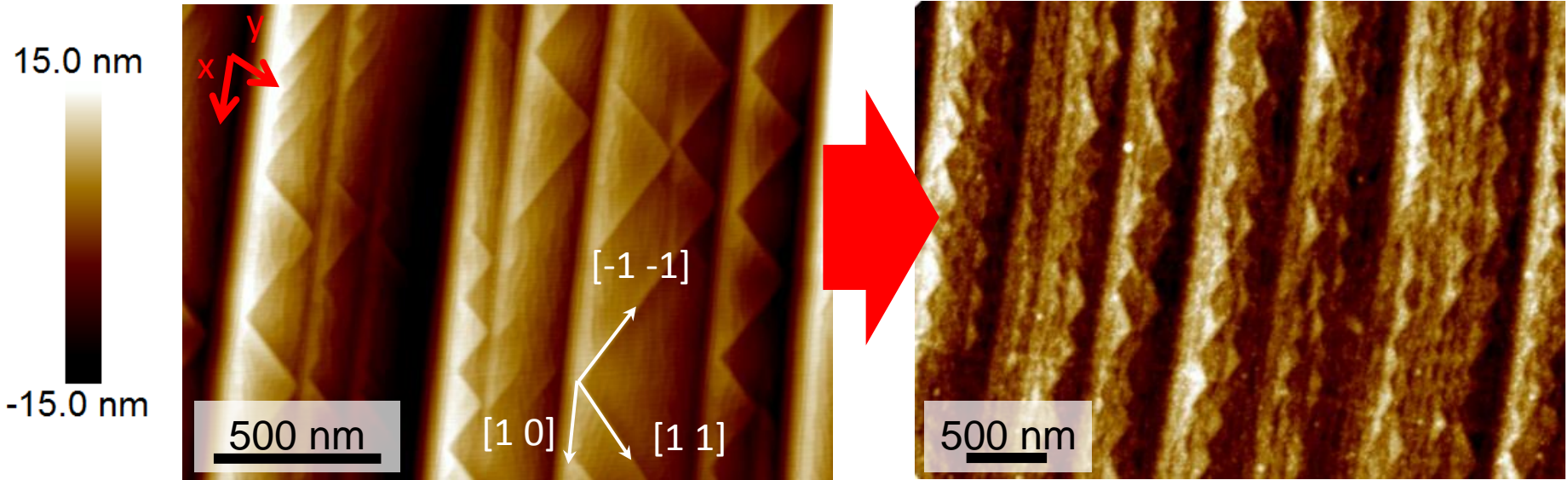


Height  
2.0 μm  
15.0 nm  
-15.0 nm  
Graphene  
Bare Cu  
Rough surface  
Oxidized Cu (amorphous)  
Step and terrace structures  
Crystalline Cu  
Mild oxidized Cu

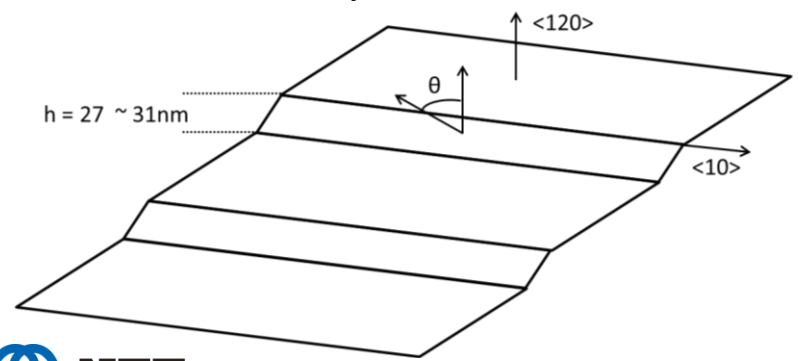
# AFM observation

As-grown sample

After vacuum annealing @ 500°C



Terrace width (nm)	534 (318-853)	609 (432-830)
Step Height (nm)	27 (14-43)	31 (11-44)



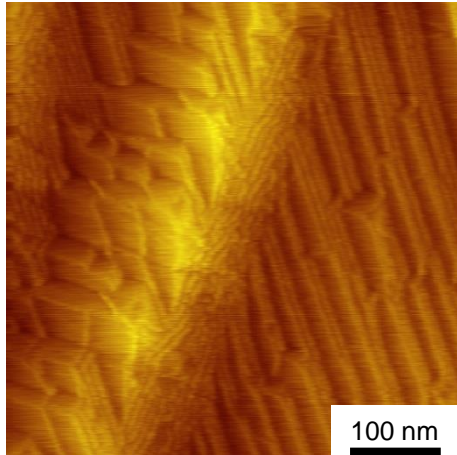
- ✓ The surface consists of (120) terraces with about 500-600 nm wide, separated by steps along <10> direction
- ✓ Long range periodic structures don't critically change, and a surface structure on the terraces are reconstructed by the annealing

# STM observations on the terraces

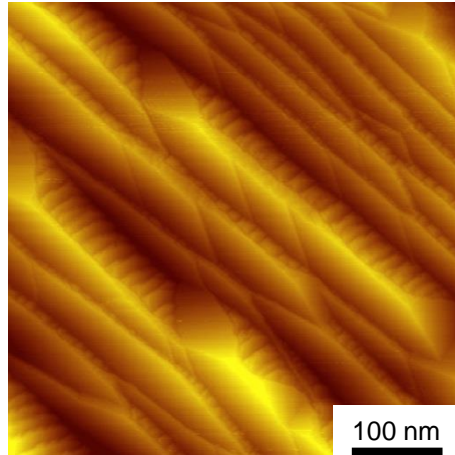


Thermal annealing in UHV ( $10^{-9}$  Torr, 10 min)

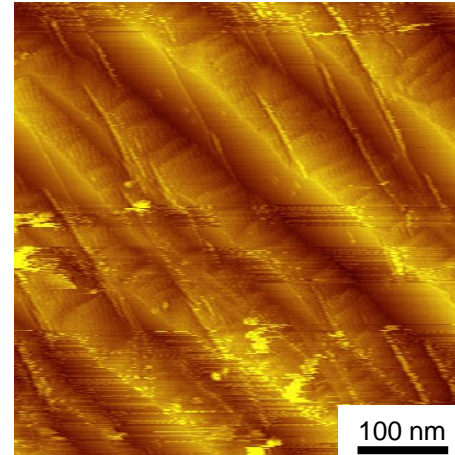
200 °C



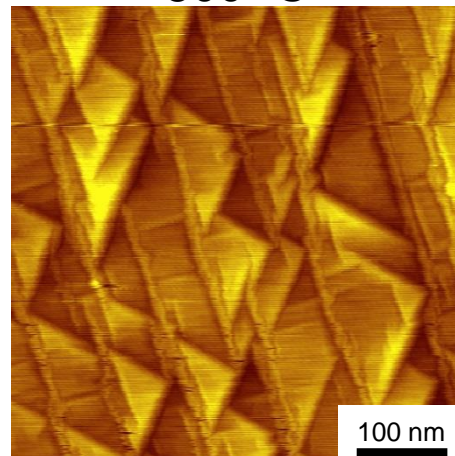
300 °C



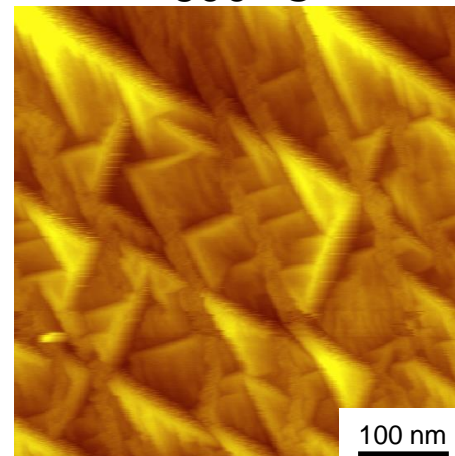
400 °C



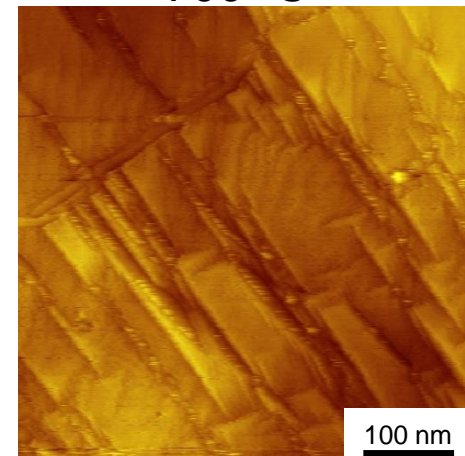
500 °C



600 °C



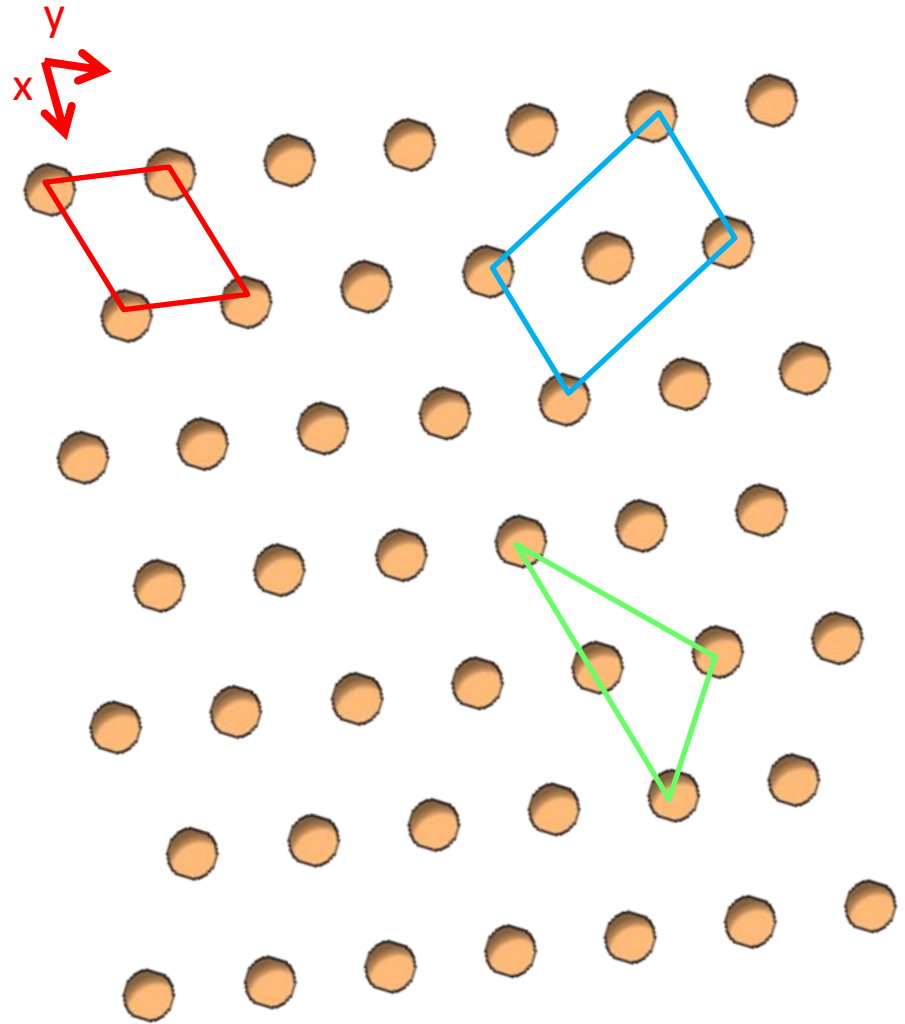
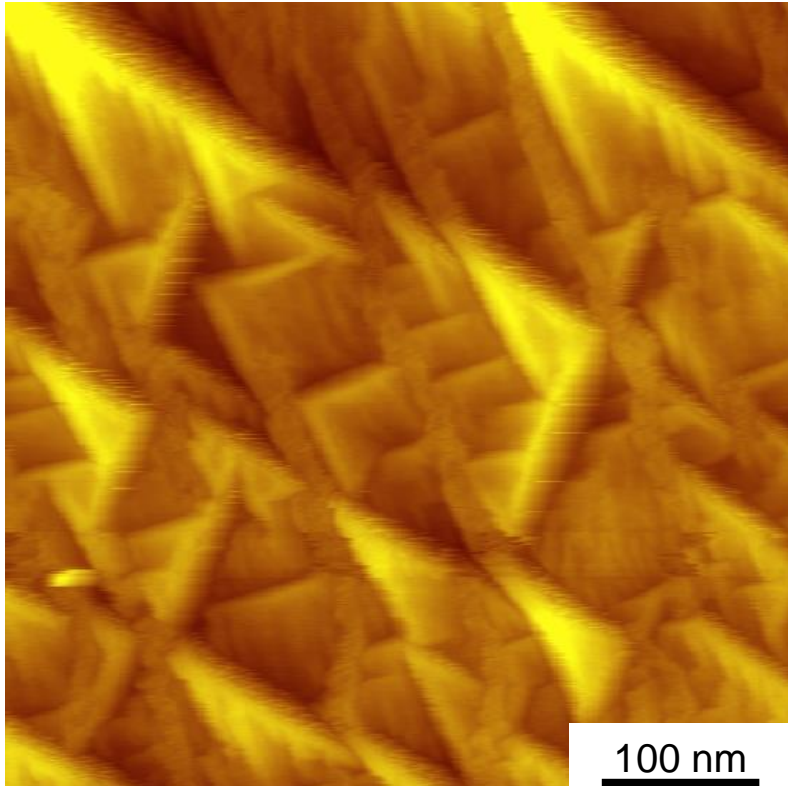
700 °C





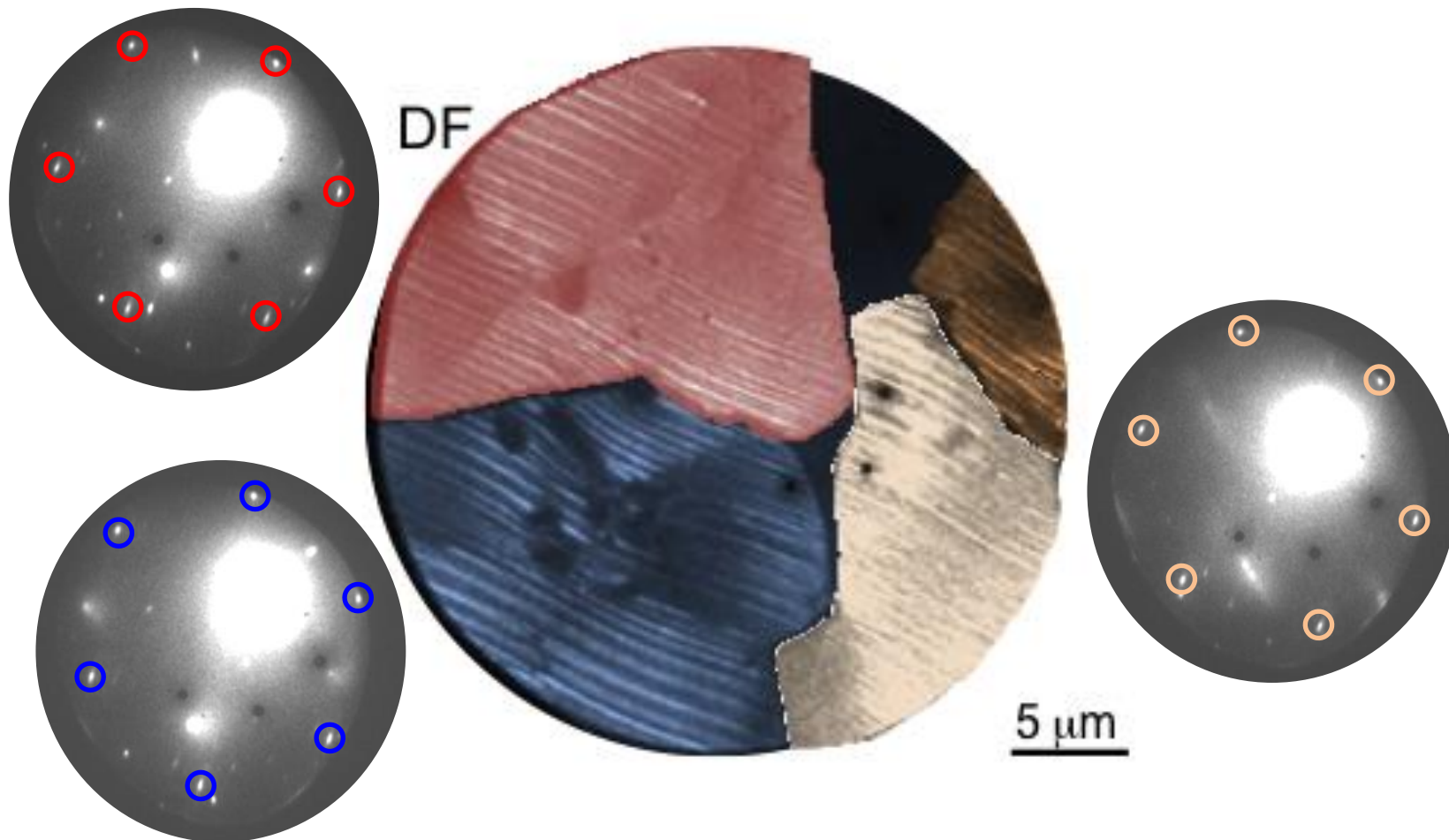
# STM observations

600 °C



# Orientation relationship between graphene and Cu{120}

## False-color Dark Field LEEM image and LEED diffractions



✓ Graphene has multiple orientations on Cu{120} plane

# Summary



- ✓ Cu {120} surface covered by single layer graphene is investigated.
- ✓ Long range periodic structures don't critically change, and a surface structure on the terraces are reconstructed by the annealing.
- ✓ Interfacial energy between Cu{120} and graphene is more important than orientation relationship of them to reconstruct Cu's interface structure.

Acknowledgement:

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